PROPULSION DIRECTORATE

Monthly Accomplishment Report
December 2003

Contents ***Page***

LITHIUM-ION BATTERIES ARRIVE ON MARS: Lithium-ion battery technology developed by the Propulsion Directorate is responsible for powering the Mars Rover "Spirit" that successfully landed on Mars on 3 January 2004. Shortly after the rover touched down on Mars, PR's Mr. Steve Vukson received a call from NASA's Jet Propulsion Laboratory (JPL) informing him that the batteries were performing their mission. The batteries, specifically designed to run the rover during the dark of night in the extreme Martian environment, had to be both lightweight and powerful. The batteries will power the rover at night and recharge during the day over a 90-day period. These batteries are the result of a joint effort between PR, NASA Glenn Research Center, and NASA JPL. This team planned and executed a rechargeable lithium-ion battery development program that addressed the many energy storage requirements facing future space missions. PR developed the battery technology, and NASA JPL and Lithion, a division of Yardney Technical Products, designed the battery. The product of this research was a battery that is lightweight, rechargeable, and much more powerful than its predecessors, and that battery is now in service on Mars. (Mr. S. Vukson, AFRL/PRPS, (937) 255-5461)

Lithium-ion battery technology developed by PR is being used to power the Mars rover "Spirit"

BEARING TEST SYSTEM "GETS ROLLING": The Propulsion Directorate has initiated use of a new Rolling Contact Fatigue (RCF) test system to permit the assessment of aerospace bearing material and lubricant compatibility. The new RCF test system doubles the current in-house test capacity and will allow RCF data to be collected rapidly, thus enabling a timely impact on bearing material selection for advanced turbine engines. Research has shown that advanced bearing materials respond differently than the older suite of bearing materials to conventional and advanced lubricants and their additives. Compatibility testing using the RCF test system is vital to ensuring optimal bearing and lubricant performance for future systems under development in the

Versatile Affordable Advanced Turbine Engines (VAATE) Program and will benefit the Joint Strike Fighter (JSF) engine development. Without improved bearings and lubricants, advanced engines will not be able to meet their performance, cost, and life requirements. This new RCF tester was designed and installed by PR and on-site contractor, Universal Energy Systems (UES). The test system has temperature capability to 700°F and is a cost effective screening tool for lubricants and bearing materials. PR and UES are pursuing a possible Cooperative Research & Development Agreement (CRADA) to produce and sell this system commercially. (Dr. R. Wright, AFRL/PRTM, (937) 255-5568)

The Rolling Contact Fatigue (RCF) test system will permit assessment of aerospace bearing materials and lubricant compatibility

POWER CHIEF RECEIVES AIR FORCE AWARD FOR RESEARCH MANAGEMENT: Lt Col JoAnn L. Erno was recently named the winner of the 2003 Air Force Science and Engineering Award in the category of Research Management. Lt Col Erno distinguished herself as an Air Force laboratory manager as the Deputy Chief and then Chief of the Propulsion Directorate's Power Division. Not only does she possess tremendous leadership and astute technical skills, but she also has an intense enthusiasm for her work and unmatched ability to inspire passion for her vision in others. These traits have been crucial as Lt Col Erno led the Power Division through recovery from a dramatic budget cut, marshaled multiple highly visible technology programs, supercharged new hiring of young scientists and engineers, and

masterminded two impressive successes at OSD and SAF/AQ level management review panels. She championed a new superconducting generator that enables directed energy weapons, pioneered the first integrated propulsion and power effort, and orchestrated insertion of new lithium-ion batteries into military aircraft. It is notable that Lt Col Erno was also recently named the 2002 Air Force Scientist of the Year (Senior Military Category). (Col M. Heil, AFRL/PR, (937) 255-2520)

Lt Col JoAnn L. Erno was recently named the winner of the 2003 Air Force Science and Engineering Award in the category of Research Management

TESTING OF SUPERCONDUCTING COILS SUCCESSFULLY COMPLETED: The Propulsion Directorate's Superconductivity Group recently completed testing of the first superconducting magnetic coils to use industrially made yttrium barium copper oxide (YBCO) coated conductor material. The tests were conducted through different programs with Long Electromagnetics, Inc. (LEI), American Superconductor Corp. (AMSC), and SuperPower, Inc. Several different coils were fabricated and tested as part of these programs. Tests indicated that there was no reduction in the n-value (a measure of the high temperature superconducting (HTS) conductor's performance) at the 77K (-321°F) operating temperature. Furthermore, the YBCO superconducting coated conductor tested outperformed earlier generations of HTS conductor while enduring significantly greater stresses. This technology is an essential element needed to design and develop future advanced, compact, high-power generator coils for aerospace applications. Compact, high-power generators are particularly needed for airborne directed energy weapons. This coil testing was planned using Dual Use Science & Technology (DUS&T) programs with AMSC and SuperPower, and testing also was accomplished under contract with LEI.

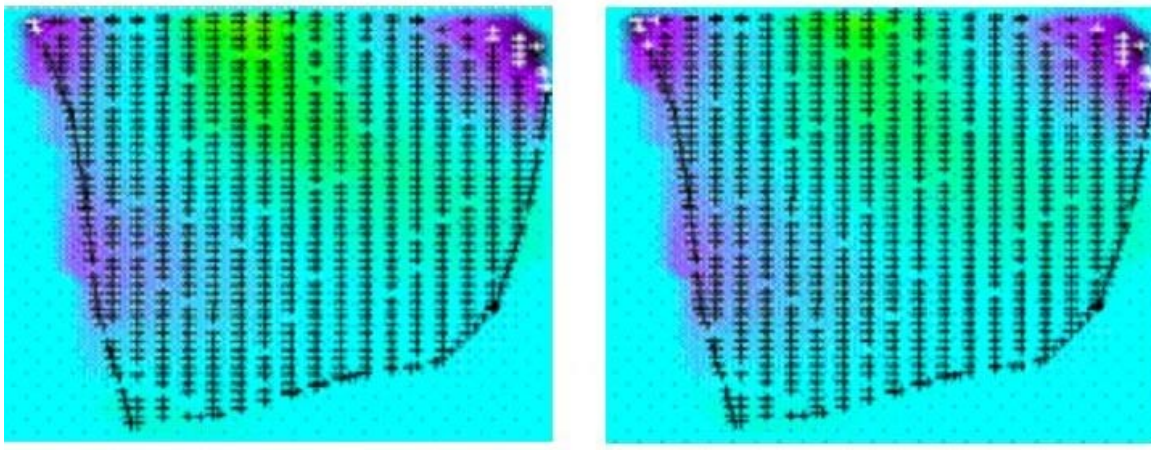
PR recently completed testing of superconducting magnetic coils constructed from industrially made YBCO

A Defense Production Act – Title III Program has been initiated to establish manufacturing facilities for the YBCO coated conductor. (Dr. P. Barnes, AFRL/PRPG, (937) 255-4410)

CONTRACTING TEAM WINS AFRL AND AFMC AWARDS: The Versatile Affordable Advanced Turbine Engines (VAATE) Contracting Team of the Propulsion Directorate's Contracting Division (AFRL/PRK) recently won two major awards. The team was first selected for the AFRL Science & Technology Contracting Team Award and then went on to win the same award at the AFMC level. These two awards will be presented at separate ceremonies in March 2004. This team transformed AFRL's business approach and developed an agile acquisition strategy (including an open solicitation and Delivery Order contracts) allowing spiral development of turbine engine technology, from basic research to advanced development, over the next seven years. This strategy permits rapid development based upon technical progress and available funding, which ultimately helps to get technology in the hands of the warfighter more quickly. Using this strategy, the team awarded 14 contracts with an estimated value of $755 million. The members of the winning team are Mr. Anthony W. Everidge, Ms. Sharon T. Shuler, Ms. Karen A. Brunn, Mr. Brian W. Allport, Ms. Robin D. Bartley, Ms. Leslie E. Smith, Ms. Melissa S. Prickett, Ms. Barbara J. Coorough, Ms. Angela G. Lauofo, Ms. Toni D. Waggoner, Ms. Katherine A. Walston, and Ms. Jane A. Hendricks. The team will now go on to compete for the Air Force level award. (Mr. A. Everidge, AFRL/PRKB, (937) 255-4818)


PR's VAATE Contracting Team recently won both the AFRL and AFMC Science & Technology Contracting Team Awards

PROGRESS IN ASSESSMENT OF HIGH CYCLE FATIGUE: The Propulsion Directorate has successfully integrated analytical methods with state-of-the-art instrumentation and test techniques to provide a highly accurate assessment of High Cycle Fatigue (HCF) and vibration response on the fan stage of the XTL17/SE1. The XTL17/SE1 is similar to a modern military gas turbine engine with technology applications relevant to the Joint Strike Fighter (JSF). Analysis and testing was conducted as part of the National HCF Initiative and a related Program Arrangement between the DoD and the UK Ministry of Defense. Blade mode shapes were measured in PR's Turbine Engine Fatigue Facility (TEFF) using scanning laser Doppler vibrometry, a state-of-the-art technique for measuring vibration over surfaces. The measurements were analytically correlated to finite element models of the fan blades, allowing for a detailed and



Comparison of HCF test data (left) with analytical results (right) shows excellent agreement between the two

accurate validation of the models. The correlation was performed by Experimental Design & Analysis Solutions Inc. (EDAS), and is one of the first applications of the HCF Test Protocol developed under the HCF Initiative. The model validation technique allows finite element models to be used to infer blade vibratory stresses relevant to HCF at any point in a blade from tip deflection measurements. Historically, stresses in blades have been measured using strain gages, but this has proven to be expensive and very unreliable. In contrast, tip deflections on every blade can be determined using new Non-Intrusive Stress Measurement (NSMS) techniques, which are reliable and require minimal instrumentation and expense. The integration of the analytical model validation techniques with NSMS data was successfully demonstrated on the XTL17/SE1 engine, helping to pave the way for transition of these technologies to the warfighter to combat HCF in current and future engines. (Dr. J. Kenyon, AFRL/PRTE, (937) 255-6802, x243)

Mr. Michael J. Kinsella was recently selected to receive the Exemplary Civilian Service Award

ATEGG ENGINEER RECOGNIZED: The Propulsion Directorate's Mr. Michael J. Kinsella was recently selected to receive the Exemplary Civilian Service Award. Mr. Kinsella was recognized for his distinguished service from January 2002 to August 2003

during which time he served as an Advanced Turbine Engine Gas Generator (ATEGG) project engineer. As an ATEGG project engineer, Mr. Kinsella provided superior engineering leadership to over 20 engineers on his technical support team. The $94 million ATEGG program that he manages is on the critical path to demonstrating the national Integrated High Performance Turbine Engine Technology (IHPTET) Program Phase III goals for the turbofan/turbojet class of engines. This class of engines is applicable to fighters, bombers, and large transport aircraft. Under the ATEGG Program, the most advanced turbine engine technology in the world will be demonstrated in a core engine environment, for the first time ever, at temperatures and pressures far in excess of today's capabilities. Mr. Kinsella is also the Versatile Core Focus Area Leader for the Versatile Affordable Advanced Turbine Engines (VAATE) Program. (Mr. R. McNally, AFRL/PRTP, (937) 255-7531)

PR PERSONNEL PLAY CENTRAL ROLE IN SUCCESSFUL JANNAF MEETING: PR personnel played a key role in the JANNAF* CS/APS/PSHS/MSS Joint Subcommittee Meeting held from 1-5 December 2003 in Colorado Springs, Colorado. This highly successful meeting, which had over 500 attendees, brought together four JANNAF subcommittees: Combustion (CS), Airbreathing Propulsion (APS), Propulsion Systems Hazards (PSHS), and Modeling and Simulation (MSS). This meeting represents an important opportunity for technical interchange for both the high speed airbreathing and rocket propulsion communities. As the current JANNAF Executive Committee Chairman, Mr. Parker Buckley, Chief of PR's Aerospace Propulsion Division, played a significant role in the planning and execution of the meeting. In addition, PR's Mr. Adam Brand served as the Technical Steering Group Chair for the Propulsion Systems Hazards Subcommittee. Mr. Brand was also a member of the Program Committee, along with several other PR employees including: Dr. Douglas L. Davis, Dr. J. Timothy Edwards, Dr. Mark R. Gruber, Dr. Thomas A. Jackson, Mr. Glenn W. Liston, Mr. Richard B. Norris, Mr. Eric Paulson, Mr. David R. Perkins, and Dr. Gregory A. Ruderman. Dr. Daniel J. Risha was co-organizer and co-chair of one of the three workshops held during the week. In addition, PR personnel chaired 7 of the technical sessions, led 4 panel meetings, and co-authored more than 25 of the papers presented. (Mr. J. Pearce, AFRL/PRO (UTC), (937) 255-5015)

Mr. Parker Buckley (right) presents an award at the December 2003 JANNAF Meeting in Colorado Springs

Want more information?

- For more info on JANNAF activities, see the JANNAF website at http://www.jannaf.org/.

* JANNAF = Joint Army-Navy-NASA-Air Force

- The January 2004 issue of the *CPIA Bulletin* features an extended article on this JANNAF Meeting, and it can be obtained at the following link: http://cpia.jhu.edu/Bulletin/PDFFiles/jan04.pdf.

CONTRACTING TRAINEE TAKES ASC HONOR: Mr. Brian Allport of the Propulsion Directorate's Contracting Division (AFRL/PRK) was recently named the ASC/PK Trainee of the Quarter for the 4th Quarter of 2003. This award is particularly noteworthy because of the competition that Mr. Allport faced, which included all of the ASC/PK contract negotiator trainees in the System Program Offices. Mr. Allport was recognized for demonstrating ability and expertise far above his experience level in providing outstanding support to AFRL/PRK. He serves as the lead Contract Negotiator for three Versatile Affordable Advanced Turbine Engines (VAATE) Programs valued at $275 million. His efforts resulted in the timely award of these contracts, which are part of a major US turbine engine research program bringing together DoD, DoE, NASA, and industry. This program has the purpose of developing both the next generation of turbine engines and component technology that can be transitioned to current production engines to improve efficiency and life. The program is critical to the future success of aircraft such as the F/A-22 and the Joint Strike Fighter. (Mr. A. Everidge, AFRL/PRKB, (937) 255-4818)

Mr. Brian Allport was recently named the ASC/PK Trainee of the Quarter for the 4th Quarter of 2003

PLAN FOR MODELING & SIMULATION PROGRAM MOVING FORWARD: The Propulsion Directorate recently received Acquisition Plan approval for an FY04 Phase III Small Business Innovation Research (SBIR) Modeling & Simulation (MS) program. This MS program will develop: (1) improved techniques and capabilities for the optimization of aircraft, spacecraft, ships, vehicles, and terrestrial energy systems, (2) high-speed interconnection of distributed simulations for integrated system design and security, (3) continuous performance prediction and monitoring of such large-scale systems employing faster-than-real-time simulation for control and survivability, and (4) training for operators of remotely controlled and semi-autonomous systems. This follow-on SBIR effort with PC Krause & Associates, Inc will allow independent component model simulations (i.e., computers) to be interconnected to form computationally efficient dynamic simulations of large-scale non-linear systems. Moreover, different simulation languages can be interconnected locally or remotely, translation to a common language is unnecessary, legacy code can be used directly, and intellectual property rights and proprietary designs are

completely protected. This capability is a simulation breakthrough that can also inexpensively provide the high-speed computation needed for fast-acting, on-line control. Although the focus thus far has been primarily in the area of electromechanical systems, it should also apply to all technical areas requiring large and intensive computational capability. (Mr. P. Lamm, AFRL/PRPE, (937) 255-4045)

SECURITY SPECIALIST RECOGNIZED FOR VOLUNTEER EFFORTS: Propulsion Directorate Security Specialist Ms. Marlene Elliott was the focus of a recent *Skywrighter*[†] article. This article highlights the volunteer work that Ms. Elliott performs in support of various charitable organizations. Of particular note are her efforts in support of Clothes That Work, a non-profit organization that provides clothing, shoes, and accessories for people leaving welfare rolls and entering the work force. Ms. Elliott has successfully exploited her connections with Federally Employed Women (FEW) and the National Management Association (NMA) to spread the word about Clothes That Work and increase contributions to the program. In addition, as state president of Women of Today (formerly Jaycee Women), she oversees the charitable donations of the Dayton "Buckeye" Chapter, and she received a presidential medallion for her work at the annual Women of Today convention. She has also helped with contributions to the Women's Recovery Center in Xenia, Ohio, where she serves on the board of directors, and she has delivered donations to the American Red Cross emergency housing office in Dayton and the Greene County homeless shelter in Xenia. Ms. Elliott is a recent recipient of the Angel Award for her laudable volunteer efforts. (S. Steltz, AFRL/PROB, (937) 255-1889)

Ms. Marlene Elliott was the focus of a recent *Skywrighter* article on her extensive volunteer work

Want more information?

- The *Skywrighter* article about Ms. Elliott is available on line at the following link: http://www.skywrighter.com/commlife/2003/1219/25volunteer.asp.

PR CHIEF SCIENTIST SELECTED FOR PRESIDENTIAL AWARD: Dr. Alan Garscadden, the Propulsion Directorate's Chief Scientist, was recently selected for the Presidential Rank Award of Meritorious Senior Professionals. Each year, the President recognizes and celebrates a small group of career Senior Executives with the Presidential Rank Award for exceptional long-term accomplishments. Winners of this prestigious award are leaders, professionals, and scientists who achieve results and consistently demonstrate strength, integrity, industry, and a relentless

[†] Mike Wallace, "Base Volunteer Knows Clothes That Work," *Skywrighter*, December 19, 2003, p. 1C.

commitment to excellence in public service. In his role as PR's Chief Scientist, Dr. Garscadden is a technical advisor to the director on a wide spectrum of aeronautical research, including many facets of propulsion, aerospace power, hypersonics, laser physics, combustion, and plasma phenomena and applications. Dr. Garscadden has served as PR's Chief Scientist since 1997. (Col M. Heil, AFRL/PR, (937) 255-2520)

Want more information?

- Dr. Garscadden's official bio is available at http://www.af.mil/bios/bio_5500.shtml.
- More information on the Presidential Rank Awards can be found at the following website: http://www.opm.gov/ses/presrankaward.html.

Dr. Alan Garscadden, PR Chief Scientist, was recently selected for the Presidential Rank Award of Meritorious Senior Professionals